International Journal of Agricultural
Science and Research (IJASR)
ISSN(P): 2250-0057; ISSN(E): 2321-0087
Vol. 5, Issue 5, Oct 2015, 367-374

HETEROSIS STUDIES IN QUALITY PROTEIN MAIZE

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ABSTRACT

An investigation was conducted to asses the standard heterosis with respect to grain yield and its attributing traits in maize at Department of Genetics and Plant Breeding, University of Agricultural Sciences, GKVK Bangalore and Zonal Agricultural research station, VC farm Mandya during 2012-2013. The 40 crosses from crossing 20 lines and 2 testers in L × T mating design were evaluated with parents and two checks namely NAH 1137 and Shaktiman-3. The crosses MAI QPM -28 x MAI 155, MAI QPM-34 x MAI 155 and MAI QPM -37 x MAI 136 exhibited significant positive standard heterosis for grain yield over two checks (NAH 1137 and Shaktiman-3). The only one cross MAI QPM 28 x MAI 136 exhibited significant standard heterosis over the check Shaktiman-3 (Total protein content check) for protein content.

KEYWORDS: Heterosis and QPM (Quality Protein Maize)

INTRODUCTION

Breeding crops with improved nutritional quality is one of the economical and most reliable means of mitigating malnutrition. Among many quality (nutritional) traits that seek immediate attention for their improvement, protein stands first. Extensive efforts have been made by plant breeders to improve protein content in rice, wheat, maize and other crops. This argues well for the breeders to develop hybrids with high nutritional qualities apart from high productivity. In India, under the auspices of All India Coordinated Research Project on Maize, a humble beginning on QPM breeding was made with the introduction of mutant gene "opaque-2" and soft endosperm quality nutritious composites viz., Rattan, Proteina and Shakti were released during early seventies. QPM's nutritional superiority having higher biological value, increased availability and better utilization of niacin, calcium, carbohydrate and carotene has been amply demonstrated with different experiments on rats, pigs, infants, school children's and vulnerable sections of the society (old aged, women in pregnancy, lactation). Therefore, it is essential to replace the present maize hybrids with new QPM maize hybrids which are similar in cultivation, grain yield potentiality, tolerance to biotic and abiotic stresses with that of normal maize hybrids under cultivation. Thus, there is a need at present to evolve new high yielding QPM hybrids, exceeding the yields of existing best hybrids in terms of quantity and quality.

MATERIALS AND METHODS

The experimental material for the present study comprised fourty QPM hybrids obtained by crossing 20 inbred lines with two testers namely MAI 155 and MAI 136 .The two checks used were NAH 1137, as grain yield check and Shaktiman-3, as total protein content check. The fourty hybrids were evaluated during summer 2013 in two locations viz., Bangalore and Mandya districts of Karnataka.

The observations were recorded for grain yield and its attributing traits namely plant height, ear height, cob length, cod diameter, kernels row^{-1}, grain yield plant^{-1}, protein content (estimated in Near Infrared Spectroscopy).

Estimation of Standard Heterosis

The pooled mean values for each trait recorded over two locations were used for the estimation of heterosis. Heterosis over standard check (SC) was computed by the method suggested by Turner (1953) and Hayes *et al.* (1955).

$$\text{Heterosis over standard check (\%)} = \frac{F_1 - \text{SC}}{\text{SC}} \times 100$$

To compute the standard error (SE) for testing the significance of the estimates of heterosis, mean squares due to error (Me) general ANOVA was considered.

$$\text{SE for heterosis over standard check (SC)} = \left(\frac{2\text{Me}}{\text{r}}\right)^{1/2}$$

Where,

Me = Error MSS in general ANOVA table

r = Number of replications

F_1 = Mean value of hybrid over two replication

SC = Mean value of standard check over two replication

Further't' statistic is calculated to test the significance for heterosis

$$\text{'t' statistic for standard heterosis} = \frac{F_1 - \text{SC}}{\text{SE (SC)}} \times 100$$

The calculated 't' statistic was compared with table't' value at error degrees of freedom of ANOVA.

RESULTS AND DISCUSSIONS

Plant height is an important quantitative character in maize. One hybrid (MAI QPM 39 × MAI 136) significantly surpassed the check NAH 1137 and five other hybrids (MAI QPM 2 × MAI 155, MAI QPM 10 × MAI 136 and MAI QPM 11 × MAI 155, MAI QPM 23 × MAI 155 and MAI QPM 39 × MAI 136) significantly surpassed the check Shaktiman-3 . Ganguli *et al*. (1989) and Bajaj *et al*. (2007) also reported positive standard heterosis for plant height.

The hybrids with negative heterosis for ear height are preferred in maize, as ear height is negatively correlated with lodging. All most all the crosses exhibited negative significant heterosis over NAH 1137 and 13 crosses surpassed the check Shakthiman-3.

Cob length is one of the important grain yield attributing traits in maize. Most of the test hybrids, exhibited significant positive standard heterosis over both the checks Apart from cob length, cob diameter is also one of the important traits which indirectly contributes to grain yield, by increased kernel rows cob^{-1}, and there by increased grains cob^{-1}. The crosses MAI QPM -26 x MAI 155 (over NAH-1137), MAI QPM -24 x MAI 136 and MAI QPM 12 x MAI 136 (over Shakthiman-3) exhibited positive standard heterosis for cob diameter. These results were in accordance with Ananth (2004), Abhishek (2006) and Bajaj *et al*. (2007)

All crosses exhibited positive standard heterosis for kernels row^{-1} over both the checks, in accordance to the earlier reports of Presolska and Kamara (1991) and Salillari and Hoxha (1998). The cross MAI QPM 2 x MAI 155 express highest significant heterosis over both standard checks.

The crosses MAI QPM -28 x MAI 155, MAI QPM-34 x MAI 155 and MAI QPM -37 x MAI 136 exhibited significant positive standard heterosis for grain yield over both the checks. Kernel size of QPM hybrids are less when compared to normal maize hybrids due to less dry matter accumulation (Arimuzzaman *et al*., 2011). Hence the grain yield of hybrids reduces comparatively. None of the crosses showed significant heterosis for protein content in desirable direction (positive) over Shakthiman-3 except MAI QPM 28 x MAI 136. However, 36 crosses exhibited positive significant heterosis over NAH 1137.

CONCLUSIONS

The present study has resulted in the identification of superior hybrids for higher grain yield, protein content and also hybrids with both higher grain yield and protein content. The crosses MAI QPM -28 x MAI 155, MAI QPM-34 x MAI 155 and MAI QPM -37 x MAI 136 exhibited significant positive standard heterosis for grain yield over two checks (NAH 1137 and Shaktiman-3). The only one cross MAI QPM 28 x MAI 136 exhibited significant standard heterosis over the check Shaktiman-3 (Total protein content check) for protein content.

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APPENDICES

Table 1: Estimates of Heterosis over Standard Checks for Grain Yield and its Attributing Traits in Maize

Sl. No.	Hybrids	Plant Height(cm)		Ear Height(cm)		Cob Length (cm)		Cob Diameter (cm)	
		NAH 1137	Shaktiman-3	NAH 1137	Shaktiman-3	NAH 1137	Shaktiman-3	NAH 1137	Shaktiman-3
1	MAI QPM - 2 × MAI 136	-6.11*	0.73	27.29 **	17.04 **	-9.09	-6.04	-8.59*	5.79*
2	MAI QPM - 2 × MAI 155	-0.06	7.23	25.61 **	15.50 *	-10.77	-7.79	-6.57*	8.13*
3	MAI QPM - 4 × MAI 136	-10.38 **	-3.84	9.5	0.69	-17.96	-15.21	-17.82 **	-4.89
4	MAI QPM - 4 × MAI 155	-4.41	2.56	6.56	-2.02	-17.35	-14.59	-27.34 **	-15.91 *
5	MAI QPM - 6 × MAI 136	-11.47 **	-5.01	6.18	-2.36	-13.88	-11	-20.50 **	-7.99*
6	MAI QPM - 6 × MAI 155	-6.26*	0.57	6.83	-1.77	-16.03	-13.22	-20.06 **	-7.48*
7	MAI QPM - 10 × MAI 136	0.87	8.23 *	11.19	2.25	-9.5	-6.47	-8.15*	6.3*
8	MAI QPM - 10 × MAI 155	-16.72 **	-10.64 **	27.39 **	17.14 **	-16.03	-13.22	-25.68 **	-13.99 *
9	MAI QPM - 11 × MAI 136	-5.7*	1.18	19.60 **	9.98	-9.49	-6.46	-10.1	4.04*
10	MAI QPM - 11 × MAI 155	1.55	8.95 *	22.33 **	12.49	-11.47	-8.51	-16.89 **	-3.81*
11	MAI QPM - 12 × MAI 136	-13.58 **	-7.28	11.89	2.88	-17.12	-14.34	-20.85 **	-8.4*
12	MAI QPM - 12 × MAI 155	-1.28	5.92	14.83 *	5.59	59.65 **	50.12 **	-11.98 *	1.87
13	MAI QPM - 15 × MAI 136	-12.94 **	-6.59	19.27 **	9.67	-16.35	-13.55	-24.60 **	-12.74 *

14	MAI QPM -15 × MAI 155	-22.75 **	-17.12 **	8.98	0.21	-13.4	-10.5	-17.39 **	-4.39
15	MAI QPM -23 × MAI 136	-15.40 **	-9.23 *	14.28 *	5.08	-15.92	-13.1	-17.17 **	-4.14
16	MAI QPM -23 × MAI 155	0.6	7.94 *	20.01 **	10.36	-13.3	-10.39	-8.01*	6.46*
17	MAI QPM -24 × MAI 136	-7.48 *	-0.73	20.58 **	10.88	-8.65	-30.03**	-8.56*	5.82*
18	MAI QPM -24 × MAI 155	-8.41 *	-1.73	20.42 **	10.73	-10.89	-7.91	-17.46 **	-4.48*
19	MAI QPM -26 × MAI 136	-9.55 **	-2.95	17.47 *	8.01	-12.21	-9.27	-11.62 *	2.29
20	MAI QPM -26 × MAI 155	-13.53 **	-7.22*	17.86 *	8.37	28.65 *	-9.27	-22.80 **	-10.65*

Table: Contd…

Sl. No.	Hybrids	Plant height(cm)		Ear height(cm)		Cob length (cm)		Cob diameter (cm)	
		NAH 1137	Shaktiman-3	NAH 1137	Shaktiman-3	NAH 1137	Shaktiman-3	NAH 1137	Shaktiman-3
21	MAI QPM -28 × MAI 136	-6.53*	0.29	-17.68 **	-4.72*	12.94	3.85	-11.56**	-8.6*
22	MAI QPM -28 × MAI 155	-13.06 **	-6.71*	-22.15 **	-9.9*	30.56 **	20.06 **	-3.69*	-0.47
23	MAI QPM -33 × MAI 136	-5.21	1.71	-16.67 **	-3.56	11.44	2.47	-13.5**	-10.6**
24	MAI QPM -33 × MAI 155	-10.45 **	-3.92	-26.33 **	-14.74 *	8.22	-0.49	-16.17**	-13.36**
25	MAI QPM -34 × MAI 136	-7.28 *	-0.52	-16.23 **	-3.06	17.07 *	7.65	-19.48**	-16.78**
26	MAI QPM -34 × MAI 155	-6.67	0.14	-12.56 *	1.2	34.43 **	23.62 **	-10.16**	-7.15*
27	MAI QPM -35 × MAI 136	-8.04 *	-1.33	-22.87 **	-10.74*	16.36 *	7	-13.65**	-10.75**
28	MAI QPM -35 × MAI 155	-6.87	-0.08	-16.02 **	-2.81	23.65 **	13.70 *	-11.66**	-8.7*
29	MAI QPM -37 × MAI 136	2.57	10.05 **	-15.37 **	-2.05	23.08 **	13.18 *	-5.86**	-2.71
30	MAI QPM -37 × MAI 155	-21.92 **	-16.23 **	-30.09 **	-19.09 **	3.96	-4.41	-23.42**	-20.85**
31	MAI QPM -38 × MAI	-3.77	3.25	-6.85	7.8*	23.97 **	14.00 *	-9.47*	-6.44*

	136								
32	MAI QPM -38 × MAI 155	-8.91 *	-2.26	-11.09 *	2.9	0.59	-7.51	-22.9**	-20.32**
33	MAI QPM -39 × MAI 136	4.53*	12.15 **	-7.79	6.71*	7.77	-0.9	-16.84**	-14.05**
34	MAI QPM -39 × MAI 155	-7.77 *	-1.05	-13.64 *	-0.05	16.31 *	6.95	-15.85**	-13.03**
35	MAI QPM -43 × MAI 136	-8.34 *	-1.65	-11.90 *	1.95	10.96	2.03	-9.8*	-6.78*
36	MAI QPM -43 × MAI 155	-3.96	3.04	-9.31	4.96*	19.66 **	10.03	-8.64*	-5.58*
37	MAI QPM -44 × MAI 136	-4.91*	2.03	-29.58 **	-18.50 **	9.48	0.67	-10.72*	-7.73*
38	MAI QPM -44 × MAI 155	-11.13 **	-4.65*	-8.58	5.8*	21.14 **	11.39	-9.49*	-6.46*
39	MAI QPM -46 × MAI 136	-0.41	6.85*	-5.34	9.55*	12.08	3.06	-21.45**	-18.82**
40	MAI QPM -46 × MAI 155	-13.51 **	-7.2*	-24.96 **	-13.16*	25.74 **	15.62 *	-18.39**	-15.66**

Table: Contd…

Sl.No.	Hybrids	Kernels row-1		Grain yield plant^{-1} (g)		Protein content (%)	
		NAH 1137	Shaktiman-3	NAH 1137	Shaktiman-3	NAH 1137	Shaktiman-3
1	MAI QPM -2 × MAI 136	48.32 **	35.38 **	-6.87	-11.07*	19.44*	-8.52*
2	MAI QPM -2 × MAI 155	58.43 **	44.60 **	22.37**	16.85*	0.55	-22.99 *
3	MAI QPM -4 × MAI 136	33.97 **	22.28**	-16.8*	-20.55**	23.01*	-5.79
4	MAI QPM -4 × MAI 155	19.38**	8.97*	-20.54**	-24.12**	24.14 *	-4.92
5	MAI QPM -6 × MAI 136	25.24**	14.31**	-16.27**	-20.05**	25.08 *	-4.2
6	MAI QPM -6 × MAI 155	20.67**	10.14**	-22.62**	-26.11**	13.34*	-13.19**
7	MAI QPM -10 × MAI 136	22.6**	11.9**	-18.99**	-22.64**	25.25 *	-4.07
8	MAI QPM -10 × MAI 155	42.80 **	30.34 *	-5.22	-9.49	32.59 **	1.55
9	MAI QPM -11 × MAI 136	41.28 **	28.95 *	0.29	-4.23	26.80 *	-2.88
10	MAI QPM -11 × MAI 155	42.29 **	29.87 *	12.13**	7.07	34.19 **	2.78
11	MAI QPM -12 × MAI 136	35.44 **	23.62**	-22.08**	-25.59**	19.6*	-8.4*
12	MAI QPM -12 × MAI 155	40.94 **	28.64 *	-8.06	-12.2	29.62 *	-0.72

13	MAI QPM -15 × MAI 136	38.23 **	26.17 *	-15.16*	-18.99**	15.81*	-11.3
14	MAI QPM -15 × MAI 155	18.61**	8.26**	-26.93**	-30.22 **	35.47 **	3.75
15	MAI QPM -23 × MAI 136	41.73 **	29.37 **	-6.53	-10.75*	23.03*	-5.77
16	MAI QPM -23 × MAI 155	47.01 **	34.18 **	13.56*	8.44	26.05 **	-3.46
17	MAI QPM -24 × MAI 136	41.78 **	29.41 **	-3.82	-8.16	15.5*	-11.54*
18	MAI QPM -24 × MAI 155	36.20 **	24.32**	9	4.09	16.31*	-10.92*
19	MAI QPM -26 × MAI 136	40.13 **	27.90 **	-4.53	-8.83	7.06	-18
20	MAI QPM -26 × MAI 155	36.81 **	24.87**	8.89	3.98	18.66**	-9.12

Table: Contd…

Sl.No.	Hybrids	Kernels row-1		Grain yield plant^{-1} (g)		Protein content (%)	
		NAH 1137	Shaktiman-3	NAH 1137	Shaktiman-3	NAH 1137	Shaktiman-3
21	MAI QPM -28 × MAI 136	21.66**	11.04**	-2.39	-6.79	38.98 **	9.45*
22	MAI QPM -28 × MAI 155	54.37 **	40.90 **	44.92 **	38.39 **	31.51 *	0.72
23	MAI QPM -33 × MAI 136	35.59 **	23.76	-24.06**	-27.49 *	28.16 *	-1.84
24	MAI QPM -33 × MAI 155	33.70 **	22.03**	-8.88	-12.98*	33.39 **	2.16
25	MAI QPM -34 × MAI 136	27.61**	16.47	-19.37*	-23	5.92	-18.07*
26	MAI QPM -34 × MAI 155	65.53 **	51.09 **	20.69**	15.24*	25.33 *	-4.01
27	MAI QPM -35 × MAI 136	15.27**	5.22	-15.51*	-19.32**	22.62*	-6.09
28	MAI QPM -35 × MAI 155	44.78 **	32.14 *	3.33	-1.32	16.5*	-10.77*
29	MAI QPM -37 × MAI 136	30.92 **	19.5*	16.09*	10.86	15.37*	-11.64*
30	MAI QPM -37 × MAI 155	35.64 **	23.81**	-26.34**	-29.67 **	21.68*	-6.81
31	MAI QPM -38 × MAI 136	45.34 **	32.65 *	3.19	-1.47	15.03*	-11.9*
32	MAI QPM -38 × MAI 155	18.04*	7.74	-40.70 **	-43.38 **	30.29 *	-0.21
33	MAI QPM -39 × MAI 136	33.03 **	21.42**	-22.89*	-26.37**	3.16	-20.99 *
34	MAI QPM -39 × MAI 155	54.06 **	40.62 **	-0.53	-5.01	25.97 *	-3.52
35	MAI QPM -43 × MAI 136	39.25 **	27.10 **	-3.26	-7.62	14.98*	-11.94*
36	MAI QPM -43 × MAI 155	34.17 **	22.46**	4.17	-0.53	10.16*	-15.63*
37	MAI QPM -44 × MAI 136	42.65 **	30.20 **	-7.15	-11.34*	19.41*	-8.55
38	MAI QPM -44 × MAI 155	36.81 **	24.87**	8.04	3.16	23.84*	-5.15

39	MAI QPM -46 × MAI 136	43.51 **	30.99 **	-13.36*	-17.27*	21.01*	-7.32
40	MAI QPM -46 × MAI 155	47.42 **	34.55 **	1.2	-3.36	37.71 **	5.47